Clin Orthop Relat Res (2009) 467:2577–2586
DOI 10.1007/s11999-009-0855-1

SYMPOSIUM: ABJS CARL T. BRIGHTON WORKSHOP ON HEALTH POLICY ISSUES IN ORTHOPAEDIC SURGERY

The Impact of Physician-owned Specialty Orthopaedic Hospitals on Surgical Volume and Case Complexity in Competing Hospitals

Xin Lu MS, Tyson P. Hagen MD, Mary S. Vaughan-Sarrazin PhD, Peter Cram MD, MBA

Published online: 2 May 2009

Abstract Published studies of physician-owned specialty hospitals have typically examined the impact of these hospitals on disparities, quality, and utilization at a national level. Our objective was to examine the impact of newly opened physician-owned specialty orthopaedic hospitals on individual competing general hospitals. We used Medicare Part A administrative data to identify all physician-owned specialty orthopaedic hospitals performing total hip arthroplasty (THA) and total knee arthroplasty (TKA) between 1991 and 2005. We identified newly opened specialty hospitals in three representative markets (Durham, NC, Kansas City, and Oklahoma City) and assessed their impact on surgical volume and patient case complexity for the five competing general hospitals located closest to each specialty hospital. The average general hospital maintained THA and TKA volume following the opening of the specialty hospitals. The average general hospital also did not experience an increase in patient case complexity. Thus, based on these three markets, we found no clear evidence that entry of physician-owned specialty orthopaedic hospitals resulted in declines in THA or TKA volume or increases in patient case complexity for the average competing general hospital.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

X. Lu, T. P. Hagen, M. S. Vaughan-Sarrazin, P. Cram (✉)
Division of General Internal Medicine, Department of Internal Medicine, University of Iowa Carver College of Medicine, Iowa City VA Medical Center, Mail Stop 152, Iowa City, IA 52242, USA
e-mail: peter-cram@uiowa.edu

T. P. Hagen, M. S. Vaughan-Sarrazin, P. Cram
Center for Research in the Implementation of Innovative Strategies for Practice (CRIISP), Iowa City Veterans Administration Medical Center, Iowa City, IA, USA

Introduction

The emergence of physician-owned specialty orthopaedic hospitals has generated widespread controversy [2, 3, 7, 10, 26, 34]. Supporters suggest that by focusing hospital resources on a limited patient population, specialty hospitals can improve patient outcomes and reduce costs [2, 7, 36]. Advocates also suggest physician ownership helps align the interests of clinicians and hospital administrators in ways that benefit patients including reductions in hospital costs, improved hospital facilities, and better surgical outcomes [13, 28, 36]. Critics, including policy makers and employees at competing general hospitals, content that physician-owners have financial incentive to perform potentially unnecessary procedures and allege physician-owned specialty hospitals preferentially draw low-risk patients away from local competitors [11, 12]. As a result, general hospitals lose their most profitable patients and are left with more complex and costly high-risk patients [15]. Since orthopaedic care is often lucrative for hospitals [24] and used to cross-subsidize unprofitable service lines [4, 11], critics contend entry of physician-owned specialty hospitals damages the financial viability of full-service hospitals [15].

In recent years a number of studies have compared the complexity and outcomes of patients treated in physician-owned specialty and general hospitals [14, 16, 21, 22]; most of these studies have reported physician-owned specialty cardiac [5, 22] and orthopaedic hospitals admit [6] patients with lower mean complexity than general hospitals but have 10% to 15% lower risk-adjusted rates of adverse outcomes. These studies have typically used national data and have examined the average complexity and outcomes for all patients treated in multiple specialty hospitals despite the well-recognized fact that healthcare delivery takes place within reasonably well-circumscribed local and regional markets [1, 8, 9, 35]. Thus, it may be more appropriate to explore the impact of physician-owned specialty hospitals by conducting analyses focusing on individual healthcare markets.

The goal of our study was to examine the impact of new orthopaedic specialty hospitals on individual healthcare markets. We examined the (1) market-level characteristics of three selected markets that experienced entry of new specialty orthopaedic hospitals between 1993 and 2003; (2) impact of the specialty orthopaedic hospitals on joint arthroplasty volume in competing general hospitals, including teaching and nonteaching hospitals; (3) impact of each specialty hospital on orthopaedic patient case complexity in each of the competing hospitals.

Materials and Methods

We used Medicare Provider Analysis and Review (MedPAR) Part A data files to identify all hospitals performing primary or revision total hip arthroplasty (THA) or total knee arthroplasty (TKA) during the years 1991 to 2005 using International Classification of Diseases, 9th Clinical Modification (ICD-9-CM) procedure codes (81.51 for primary THA and 81.53 revision THA: 81.54 for primary TKA and 81.55 for revision TKA) and all patients admitted to these hospitals for these procedures [20]. The MedPAR data contain an array of information collected from discharge abstracts for all hospitalizations of fee-for-service Medicare beneficiaries and have been used extensively in prior health services research assessing orthopaedic care [6, 17, 18]. Key data elements include patient demographics; primary and secondary diagnoses and procedures; admission source (eg, outside hospital, emergency department); admission and discharge dates; each patient's Medicare beneficiary number; and the hospital to which each patient was admitted as represented by each hospital's unique Medicare identifier. We obtained additional hospital-level information such as teaching status (ie, membership in the Council of Teaching Hospitals) by linking the MedPAR data to the 2000 American Hospital Association (AHA) survey [27].

We assigned each hospital performing THA or TKA to one of 306 unique hospital referral regions (HRRs) using hospital zip code-based algorithms available from the Dartmouth Atlas of Health Care [32]. HRRs represent distinct regional markets for medical care. We obtained an array of additional information about each market including total population, per-capita supply of hospital beds, and supply of orthopaedic surgeons from information collected by the Dartmouth Atlas [32]. We obtained additional data (eg, median income) from the 2000 U.S. Census data [33].

The inclusion and exclusion criteria for identifying markets with new physician-owned specialty orthopaedic hospitals involved a series of steps. First, we identified all physician-owned specialty orthopaedic hospitals included in the MedPAR data using lists that we and others have developed previously [11]. Second, we excluded hospitals focusing exclusively on spinal surgery and then identified the year that each specialty hospital began operation—defined as the first year that the hospital performed at least one major joint arthroplasty (either total hip arthroplasty [THA] or total knee arthroplasty [TKA]) on a Medicare beneficiary. Third, we excluded all specialty hospitals that opened prior to 1993 or after 2003 to ensure we had at least 2 years of data both before and after the entry of the specialty hospital for the analyses described below. Fourth, we excluded markets lacking at least one major teaching hospital because we were interested in examining whether new physician-owned specialty hospitals might impact teaching and nonteaching general hospitals in different ways. Fifth, we excluded markets where multiple physician-owned specialty hospitals opened during the same year as this would limit our ability to examine the impact of a single new specialty hospital on competing general hospitals.

We then selected the first specialty hospital opening in each of three markets for further evaluation. For each of these markets we used zip-code-based algorithms to calculate the distance between the specialty hospital and each competing general hospital in the respective market (HRR). We selected the five nearest general hospitals in each market for further analysis, with the caveat that at least one of the comparison hospitals was required to be a major teaching hospital. If none of the nearest five comparison hospitals were major teaching hospitals, we replaced the most distant of the nonteaching hospitals with the nearest teaching hospital. To investigate the robustness of our findings, we conducted sensitivity analyses in which comparison general hospitals were defined instead as the five highest-volume general hospitals in each market with a new specialty hospitals.

After identifying the specialty and competing general hospitals in each of the three study markets, we reviewed the locations of the hospitals within each market using publicly available geographic information systems software (http://maps.google.com). Next, we selected all patients admitted to the selected specialty and general hospitals for either THA or TKA in the 2 years preceding and 3 years following the opening of the specialty hospital. Thus the current analyses are based upon 5 years of data for each hospital extending from year −2 (2 years before the specialty hospital opened) to +2 (2 years after the specialty hospital opened).

First, we calculated the total number of Medicare beneficiaries undergoing THA and TKA in each hospital in each market during each year. We also calculated the average volume of THAs and TKAs performed, in aggregate, by the five competing general hospitals in each market during the years preceding and following the opening of the specialty orthopaedic hospital. These calculations allowed us to examine changes in joint arthroplasty volume within individual general hospitals and all general hospitals as a group in individual markets before and after the opening of the physician-owned specialty hospitals. Second, we assessed the proportion of all THA and TKA procedures for each hospital classified as revision procedures for each year. Third, we estimated the overall complexity of patients receiving THA or TKA in each hospital for each year as measured by the predicted risk of early adverse orthopaedic outcomes. In particular, we developed a multivariable logistic regression model using the SAS procedure proc glimmix to calculate the predicted probability of early adverse orthopaedic outcomes in specialty and general hospitals for all patients who underwent THA or TKA in the three selected study markets between year −2 and year +2. Adverse outcomes were defined as pulmonary embolism, deep venous thrombosis, infection requiring admission, hemorrhage, and sepsis at the readmission within 90 days of the indexed surgery, or death during the index admission or readmission within 90 days of the index surgery. These outcomes were identified using coding algorithms that others and we have used previously and have been validated using medical record review [17, 19, 23]. We identified comorbid illnesses among THA and TKA patients that might constitute risk factors for adverse outcomes using algorithms described by Quan et al. [25]. Additional high-risk conditions specific to joint arthroplasty surgery (previous hip or knee arthroplasty, pathological fracture, acute fracture, and active joint infection) were identified using methods defined in prior studies using administrative data to assess orthopaedic outcomes and considered additional comorbid conditions [17].

We then fit multivariable models with the dependent variable (outcome) being an indicator variable representing whether a patient experienced an adverse outcome as defined above. The models adjusted for patient demographics, comorbidity, high-risk orthopaedic conditions, and accounted for the clustering of patients within hospitals. We applied pairwise variable selection to exclude all covariates with p value less than 0.05. We then used these models to estimate the predicted risk of adverse outcomes for each patient. We calculated the predicted risk of adverse outcomes for each hospital for each year by taking the mean predicted risk of all patients receiving THA or TKA in the specific hospital during a specific year.

Results

After identifying all specialty orthopaedic hospitals in the MedPAR data (66 hospitals in 42 markets), we excluded: hospitals focusing exclusively on spinal surgery (five hospitals in two markets); all hospitals that opened prior to 1993 or after 2003 (30 hospitals and 16 markets); markets without at least one major teaching hospital (16 hospitals in 16 markets); and markets where more than one specialty hospital opened during the same year (two hospitals in one market). This left us with 13 hospitals in seven markets from which we then selected the first specialty hospital opening in each of three markets (Durham, NC, Kansas City, and Oklahoma City) for further evaluation. The characteristics of the three selected markets experiencing the entry of new physician-owned specialty orthopaedic hospitals were generally similar (Table 1). The markets differed in several ways including population, supply of medical care and orthopaedic surgeons, and median income. The mean distance from the specialty hospitals to competing general hospitals was 15.8 miles (range, 0.5–30.9 miles) in Durham, NC, 5.24 miles (range, 1.8–9.9 miles) in Kansas City, and 5.2 miles (range, 2.2–7.6 miles) in Oklahoma City (see Appendix 1 for maps).

The volume of THA and TKA procedures performed by the specialty hospitals during their first 3 years of operation differed substantially across markets (Tables 2, 3). For example, the specialty hospitals in Durham and Oklahoma City performed relatively few major joint arthroplasties and even during their third year of operation had substantially lower joint arthroplasty volume than their competitors. Alternatively, the specialty hospital in Kansas City had greater joint arthroplasty volume than its competitors during its first year in operation. Each of the specialty hospitals performed a lower proportion of revision joint arthroplasty procedures than their competitors (Tables 2, 3).

Table 1. Characteristics of markets experiencing entry of new specialty orthopaedic hospitals

Characteristics	Durham, NC	Kansas City, MO	Oklahoma City, OK
Population	1,221,236	2,268,475	1,703,524
Medicare enrollees	148,052	206,550	194,210
Number of hospitals performing total-joint surgery	15	40	30
Number of orthopaedic surgeons per 100,000 population	7.4	6.0	6.3
Number of major teaching hospitals	2	5	1
Hospital beds per 1000 population	3.4	3.5	3.6
Median income ($)	37,058	45,996	34,616

Table 2. Volume of primary and revision THRs performed in specialty hospitals and competing hospitals in Durham, NC, Kansas City, MO, and Oklahoma City, OK

Durham, NC

Year	Specialty hospital	Hospital A (T)	Hospital B (T)	Hospital C	Hospital D	Hospital E	Mean volume (Hospitals A–E)
−2	N/A	133 (54, 40.6)	56 (26, 46.4)	* (*, 33.3)	83 (15, 18.1)	12 (*, 8.3)	58 (19.6, 33.8)
−1	N/A	137 (58, 42.3)	63 (18, 28.6)	* (*, 0.0)	67 (12, 17.9)	14 (*, 0.0)	58 (17.6, 30.3)
0	* (*, 0)	128 (42, 32.8)	72 (16, 22.2)	12 (*, 25.0)	75 (21, 28.0)	28 (*, 10.7)	63 (17, 27.0)
1	* (*, 12.5)	125 (44, 35.2)	81 (25, 30.9)	* (*, 25.0)	104 (29, 27.9)	24 (*, 12.5)	67.6 (20.4, 30.2)
2	16 (*, 12.5)	119 (43, 36.1)	68 (25, 36.8)	* (*, 22.2)	99 (29, 29.3)	22 (*, 13.6)	63.4 (20.4, 32.2)

Kansas City, MO

Year	Specialty hospital	Hospital A (T)	Hospital B	Hospital C	Hospital D	Hospital E	Mean volume (Hospitals A–E)
−2	N/A	23 (11, 47.8)	27 (*, 18.5)	n/a	26 (*, 11.5)	30 (*, 6.7)	26.5 (5.3, 19.8)
−1	N/A	19 (*, 31.6)	28 (*, 21.4)	* (n/a)	42 (*, 21.4)	38 (*, 10.5)	25.4 (5, 19.7)
0	39 (*, 2.6)	21 (*, 38.1)	31 (*, 19.4)	* (n/a)	37 (*, 8.1)	23 (*, 13.0)	22.4 (4, 17.9)
1	43 (*, 2.3)	33 (16, 48.5)	28 (*, 17.9)	* (*, 25.0)	30 (*, 30.0)	15 (*, 6.7)	22 (6.4, 29.1)
2	68 (*, 4.4)	54 (28, 51.9)	42 (*, 19.0)	10 (*,10.0)	35 (*, 14.3)	20 (*, 10.0)	32.2 (8.8, 27.3)

Oklahoma City, OK

Year	Specialty hospital	Hospital A	Hospital B (T)	Hospital C	Hospital D	Hospital E	Mean volume (Hospitals A–E)
−2	N/A	18 (*, 27.8)	21 (*, 4.8)	242 (59, 24.4)	64 (*, 1.6)	* (*, 0.0)	70.2 (13.2, 18.8)
−1	N/A	* (*, 12.5)	19 (*, 15.8)	239 (48, 20.1)	54 (*, 3.7)	* (*, 20.0)	65 (11, 16.9)
0	* (*, 0.0)	* (*, 14.3)	23 (*, 13.0)	207 (53, 25.6)	45 (*, 0.0)	* (*, 62.5)	58 (12.4, 21.4)
1	* (*, 0.0)	15 (*, 0.0)	17 (*, 23.5)	292 (77, 26.4)	31 (*, 12.9)	* (*, 0.0)	72 (17, 23.6)
2	* (*, 0.0)	* (*, 22.2)	* (*, 14.3)	286 (73, 25.5)	42 (*, 4.8)	11 (*, 45.5)	71 (16.6, 23.4)

T teaching hospital.

* Cells with less than 10 cases were suppressed in accordance with Medicare data analysis requirements.

The number outside the parentheses denotes the total number of THRs performed; the first number in the parentheses denotes the number of THRs that were revisions, the second number in the parentheses denotes the percent of total THRs that were revisions.

The impact of new specialty hospitals on THA and TKA volume in competing general hospitals appeared highly variable, with some hospitals seeing small declines in volume, while others seemed unaffected (Tables 2, 3). Entry of specialty hospitals may have resulted in increases in the proportion of procedures classified as revisions for competing teaching hospitals, though again, results appeared to vary by procedure (THA versus TKA) and by market. Looking at the overall impact of the new specialty hospitals on THA and TKA volume, there is an appearance that entry of new specialty hospitals may have led to a transient decline in both THA volume (Fig. 1) and TKA volume (Fig. 2) in competing general hospitals that abated in subsequent years. In patient case complexity, the specialty hospitals in Durham and Kansas City performed THA and TKA on patients with a lower predicted risk of adverse surgical outcomes (ie, less complex), while the Oklahoma City specialty hospital performed THA and TKA on patients with greater complexity than the competing general hospitals (Table 4). In addition, we found that while the opening of the Durham specialty hospital was associated with an increase in the complexity of patients receiving joint arthroplasty in the competing general hospitals, the entry of specialty hospitals in Kansas City and Oklahoma City did not appear to result in an increase in patient case complexity among their competitors. Results were similar when comparison general hospitals were instead defined as the five highest volume hospitals in each market.

Discussion

A number of studies have examined the impact of physician-owned specialty hospitals on disparities, quality, and healthcare utilization across the United States but these analyses have overlooked the impact of specialty hospitals on individual competing general hospitals and discrete healthcare markets. Our objective was to examine in detail the impact of newly opened physician-owned specialty orthopaedic hospitals on THA and TKA volume and patient case complexity in three distinct healthcare markets.

Table 3. Volume of primary and revision TKRs performed in specialty hospitals and competing hospitals in Durham, NC, Kansas City, MO, and Oklahoma City, OK

Durham, NC

Year	Specialty hospital	Hospital A (T)	Hospital B (T)	Hospital C	Hospital D	Hospital E	Mean volume (Hospitals A–E)
−2	N/A	147 (30, 20.4)	93 (15, 16.1)	28 (*, 3.6)	124 (*, 4.0)	24 (*, 12.5)	83.2 (10.8, 13.0)
−1	N/A	135 (21, 15.6)	89 (14, 15.7)	17 (*, 0.0)	119 (*, 6.7)	29 (*, 3.4)	77.8 (8.8, 11.3)
0	* (*, 0)	137 (26, 19.0)	84 (13, 15.5)	25 (*, 12.0)	104 (*, 8.7)	48 (*, 6.3)	79.6 (10.8, 13.6)
1	13 (*, 7.7)	153 (32, 20.9)	88 (16, 18.2)	14 (*, 14.3)	138 (15, 10.9)	62 (*, 11.3)	91 (14.4, 15.8)
2	32 (*, 6.3)	142 (15, 10.6)	104 (*, 7.7)	16 (*, 12.5)	123 (20, 16.3)	36 (*, 8.3)	84.2 (9.6, 11.4)

Kansas City, MO

Year	Specialty hospital	Hospital A (T)	Hospital B	Hospital C	Hospital D	Hospital E	Mean volume (Hospitals A–E)
−2	N/A	12 (*, 33.3)	40 (*, 10.0)	n/a	51 (*, 7.8)	50 (*, 4.0)	38.3 (3.5, 9.2)
−1	N/A	16 (*, 12.5)	60 (*, 10.0)	* (*, 0.0)	48 (*, 2.1)	57 (*, 0.0)	36.4 (1.8, 4.9)
0	78 (*, 2.6)	18 (*, 33.3)	70 (*, 8.6)	* (*, 12.5)	45 (*, 2.2)	40 (*, 2.5)	36.2 (3, 8.3)
1	103 (*, 2.3)	30 (13, 43.3)	64 (*, 7.8)	14 (*, 0.0)	67 (*, 4.5)	25 (*, 4.0)	40 (4.4, 11.0)
2	144 (*, 4.4)	36 (*, 22.2)	57 (*, 3.5)	28 (*, 10.7)	71 (*, 1.4)	46 (*, 2.2)	47.6 (3, 6.3)

Oklahoma City, OK

Year	Specialty hospital	Hospital A	Hospital B (T)	Hospital C	Hospital D	Hospital E	Mean volume (Hospitals A–E)
−2	N/A	27 (*, 7.4)	33 (*, 6.1)	508 (44, 8.7)	36 (*, 2.8)	33 (*, 9.1)	127.4 (10.4, 8.2)
−1	N/A	16 (*, 6.3)	47 (*, 4.3)	500 (66, 13.2)	44 (*, 4.5)	16 (*, 12.5)	124.6 (14.6, 11.7)
0	11 (*, 27.3)	23 (*, 8.7)	38 (*, 13.2)	443 (42, 9.5)	18 (*, 0.0)	29 (*, 10.3)	110.2 (10.4, 9.4)
1	15 (*, 0)	17 (*, 0.0)	22 (*, 22.7)	513 (56, 10.9)	12 (*, 8.3)	20 (*, 25.0)	116.8 (13.4, 11.5)
2	25 (*, 0)	13 (*, 0.0)	10 (*, 0.0)	626 (70, 11.2)	26 (*, 0.0)	28 (*, 0.0)	140.6 (14, 10.0)

T teaching hospital.

* Cells with less than 10 cases were suppressed in accordance with Medicare data analysis requirements.

The number outside the parentheses denotes the total number of TKRs performed; the first number in the parentheses denotes the number of TKRs that were revisions, the second number in the parentheses denotes the percent of total TKRs that were revisions.

The study has a number of limitations that are important to consider. First, we limited this analysis to three markets with entry of new physician-owned specialty orthopaedic hospitals. Thus, one should generalize our findings to other markets with caution. Nevertheless, we selected these three markets from the population of markets with new specialty orthopaedic hospitals and thus it is reasonable to expect the three markets provide a reasonable portrait of the impact of specialty hospitals in general. Second, our analyses were based upon Medicare Part A administrative data. While Medicare Part A data have been used for years to study orthopaedic outcomes, these data lack detailed clinical information that is important in assessing orthopaedic care including functional status and patient satisfaction. Our results highlight the need for a national orthopaedic clinical registry akin to data collected by the Society of Thoracic Surgeons and American College of Cardiology [29, 30]. It is also important to acknowledge our study was limited to Medicare beneficiaries and thus extrapolation of our findings to non-Medicare populations must be made with care. Nevertheless, the Part A data do provide important insights into the impact of specialty hospitals that cannot be gleaned from other data sources. Third, by using Part A data, we were limited to orthopaedic procedures performed in the inpatient setting and lacked information about ambulatory procedures performed in specialty hospitals. That said, we deliberately focused on THA and TKA- procedures that typically require an inpatient stay and thus are captured reliably in the Part A data. Future studies should consider use of alternative data sources that would allow study of outpatient orthopaedic procedures as well. Fourth, while the current study provides an extremely detailed examination of the impact of three new specialty orthopaedic hospitals on their competitors, the very detail we have provided limits our statistical power and precludes us from meaningful hypothesis testing. This limitation is important to acknowledge, but does not limit the importance of our analysis in providing a “field-level” view of how entry of new specialty orthopaedic hospitals are affecting healthcare markets.

We found the markets that specialty orthopaedic hospitals enter differ in terms of population, physician supply, and geography. While prior studies, both by the federal

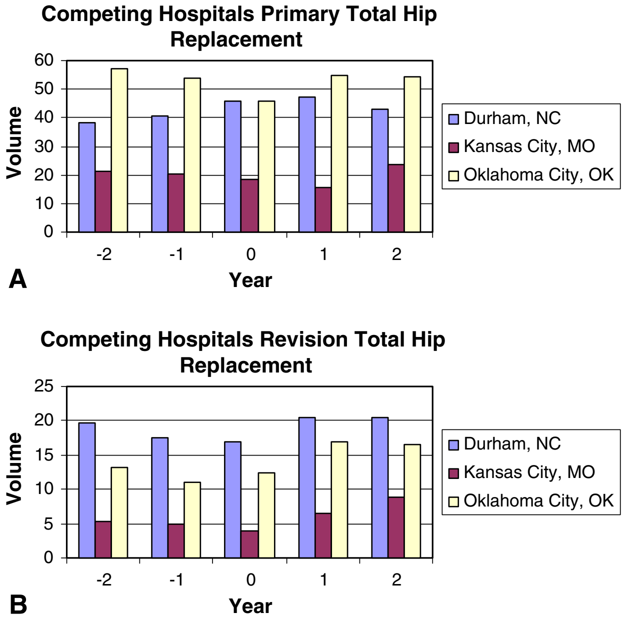


Fig. 1A–B (**A**) This figure displays trends in the mean primary THR volume in the competing general hospitals in each of the study markets with Year 0 representing the year the specialty hospital opened in each market. (**B**) Trends in the mean revision THR volume in the competing general hospitals in each of the study markets with Year 0 representing the year the specialty hospital opened in each market are shown.

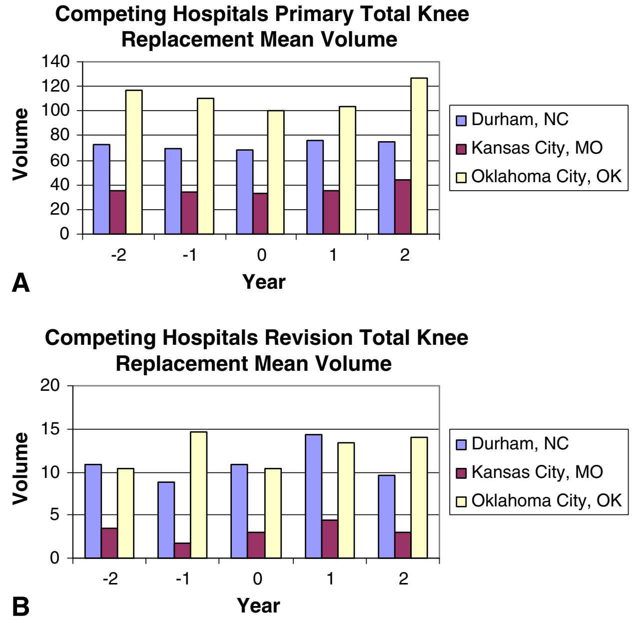


Fig. 2A–B (**A**) This figure displays trends in the mean primary TKR volume in the competing general hospitals in each of the study markets with Year 0 representing the year the specialty hospital opened in each market. (**B**) Trends in the mean revision TKR volume in the competing general hospitals in each of the study markets with Year 0 representing the year the specialty hospital opened in each market are shown.

Table 4. Predicted risk of adverse outcomes at 90 days for THRs and TKRs performed in specialty hospitals and competing hospitals in years preceding and following the opening of the specialty hospitals

THR						
Year	Durham, NC		Kansas City, MO		Oklahoma City, OK	
	Specialty (%)	General (%)	Specialty (%)	General (%)	Specialty (%)	General (%)
−2	N/A	4.8 ± 4.5	N/A	4.4 ± 4.0	N/A	7.5 ± 9.6
−1	N/A	4.7 ± 5.5	N/A	8.0 ± 10.4	N/A	4.8 ± 7.8
0	1.6 ± 0.4	4.7 ± 4.2	2.7 ± 1.4	7.3 ± 9.0	3.7	9.1 ± 14.8
1	1.7 ± 0.4	5.3 ± 4.4	2.2 ± 1.3	5.7 ± 6.5	5.1 ± 0.7	8.2 ± 11.8
2	1.6 ± 0.3	5.6 ± 4.5	1.7 ± 1.0	7.4 ± 12.6	4.3 ± 0.7	5.6 ± 8.5
TKR						
Year	Durham, NC		Kansas City, MO		Oklahoma City, OK	
	Specialty (%)	General (%)	Specialty (%)	General (%)	Specialty (%)	General (%)
−2	N/A	3.4 ± 2.0	N/A	4.0 ± 5.0	N/A	5.2 ± 6.0
−1	N/A	3.4 ± 3.1	N/A	4.7 ± 5.6	N/A	3.1 ± 6.1
0	1.4 ± 0.4	3.7 ± 2.8	2.3 ± 1.3	5.7 ± 6.3	5.1 ± 1.3	4.5 ± 6.5
1	1.3 ± 0	4.2 ± 3.6	2.3 ± 1.4	4.5 ± 5.0	5.4 ± 1.3	5.6 ± 8.3
2	1.3 ± 0.2	4.1 ± 3.2	1.8 ± 1.2	4.9 ± 6.4	4.5 ± 0.7	5.1 ± 9.1

government and private think tanks, have used site visits and surveys to examine the impact of specialty hospitals, we believe this is the first study to systematically investigate factors related to supply and demand for orthopaedic care in markets with new specialty hospitals.

We found orthopaedic volume varied substantially across individual specialty hospitals. While some of the hospitals seemed to develop rapidly into high-volume joint replacement programs, others did not. For example, the specialty hospital in Kansas City grew rapidly after opening while the hospitals in Durham and Oklahoma City did not. Likewise, we found some of the competing general hospitals appeared to experience a rapid decline in joint replacement volume following entry of the new specialty hospitals while other general hospitals appeared relatively unaffected. Government regulators and policy makers have often depicted specialty hospitals as universally successful and directly damaging to general hospitals [11, 31]. Our data serve to highlight the fact that the success of specialty hospitals is highly variable as is their impact on competing general hospitals.

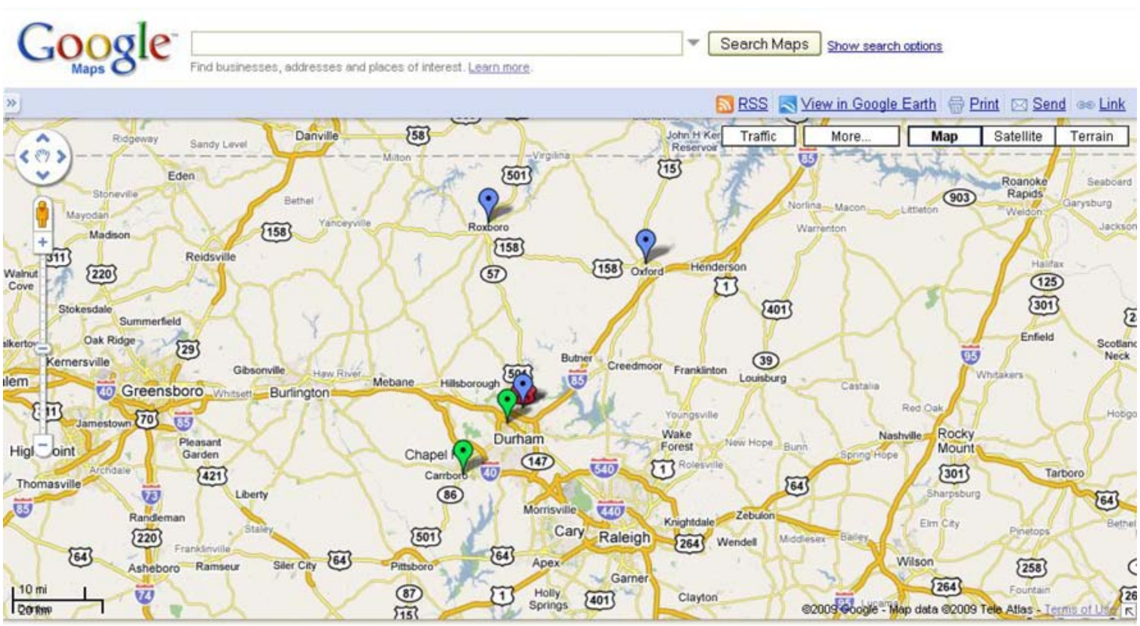
The impact of new specialty orthopaedic hospitals on patient case complexity in general hospitals also appeared highly variable. We saw some suggestion that entry of specialty hospitals may have led to a higher proportion of revision procedures in competing teaching hospitals, but this effect was by no means universal. We also found no clear evidence specialty hospitals, as a group, selected less complex patients for admission or consistently resulted in a more complex patient mix for their competitors. In aggregate, these findings again reinforce the fact that the behavior and impact of new specialty hospitals is highly variable across markets.

Our data provide evidence the entry of new physician-owned specialty orthopaedic hospitals does not dramatically reduce surgical volume or increase patient case complexity for competing general hospitals. Administrators and policy makers should be reassured by these data and investigate allegations against individual specialty hospitals on a case-by-case basis.

Appendix 1

Locations of specialty and general hospitals in the three markets of interest (denotes orthopaedic specialty hospitals, denotes teaching hospitals, and denotes general hospitals)

Durham, NC



North Carolina Specialty Hospital
3916 Ben Franklin Blvd.
Durham, NC 27704

Duke University Medical Center
2301 Erwin Road
Durham, NC 27710

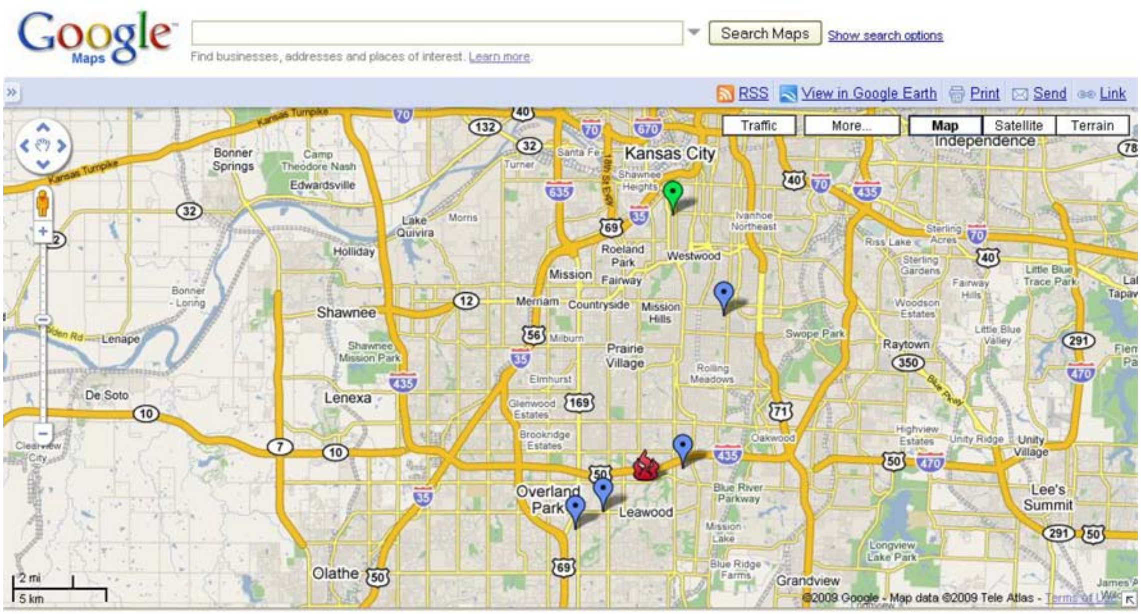
University of North Carolina Hospital
101 Manning Drive
Chapel Hill, NC 27514

Durham Regional Hospital
3643 North Roxboro Road
Durham, NC 27704

Granville Medical Center
1010 College Street
Oxford, NC 27565

Person Memorial Hospital
615 Ridge Road
Roxboro, NC 27573

Kansas City, MO



Kansas City Orthopaedic Institute
3651 College Boulevard
Leawood, KS 66211

The University of Kansas Hospital
3901 Rainbow Boulevard
Kansas City, KS 66160-7220

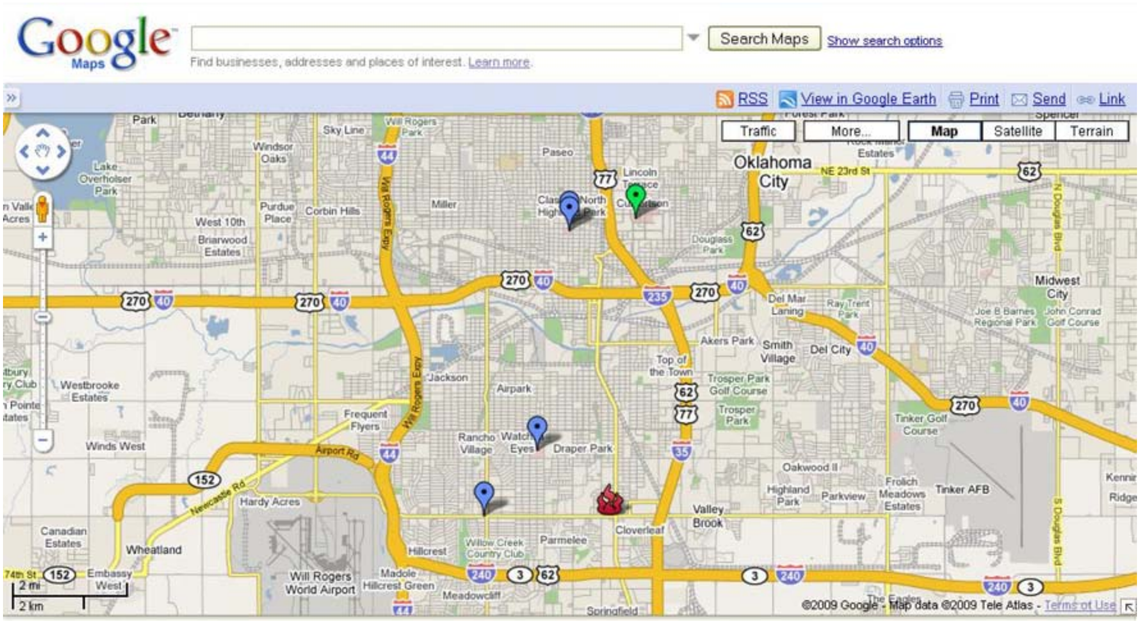
Menorah Medical Center
5721 West 119th Street
Overland Park, KS 66209-3722

Baptist Medical Center
6601 Rockhill Road
Kansas City, MO 64131

Saint Luke's South
12300 Metcalf Avenue
Overland Park, KS 66213

Saint Joseph Medical Center
1000 Carondelet Drive
Kansas City, MO 64114

Oklahoma City, OK



Surgical Hospital of Oklahoma LLC
100 Southeast 59th Street
Oklahoma City, OK 73129

Oklahoma University Medical Center
1200 Everett Drive
Oklahoma City, OK 73104

Bone & Joint Hospital
1111 North Dewey Avenue
Oklahoma City, OK 73103

Saint Anthony Hospital
1000 North Lee Street
Oklahoma City, OK 73102

INTEGRIS Southwest Medical Center
4401 South Western
Oklahoma City, OK 73109

Hillcrest Health Center Inc
2129 SW 59th Street
Oklahoma City, OK 73119

References

1. Birkmeyer JD, Sharp SM, Finlayson SR, Fisher ES, Wennberg JE. Variation profiles of common surgical procedures. *Surgery.* 1998;124:917–923.
2. Casalino LP, Devers KJ, Brewster LR. Focused factories? Physician-owned specialty facilities. *Health Aff.* 2003;22:56–67.
3. Casey J. The case for specialty hospitals. *Mod Healthc.* 2004;34:21–22.
4. Center for Medicare & Medicaid Services. Study of physician-owned specialty hospitals required in section 507(c)(2) of the medicare modernization act of 2003. Center for Medicare & Medicaid Services; 2005.
5. Cram P, Rosenthal GE, Vaughan-Sarrazin MS. Cardiac revascularization in specialty and general hospitals. *N Engl J Med.* 2005;352:1454–1462.
6. Cram P, Rosenthal GE, Vaughan-Sarrazin MS, Wolf B, Katz JN. A comparison of total hip and knee replacement in specialty and general hospitals. *J Bone Joint Surg Am.* 2007;89:1675–1684.
7. Devers KJ, Brewster LR, Ginsburg PB. Specialty hospitals: focused factories or cream skimmers? *Issue Brief Cent Stud Health Syst Change.* 2003;62:1–4.
8. Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implications of regional variations in Medicare spending. Part 1: the content, quality, and accessibility of care. *Ann Intern Med.* 2003;138:273–287.
9. Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EtL. The implications of regional variations in Medicare spending. Part 2: health outcomes and satisfaction with care. *Ann Intern Med.* 2003;138:288–298.
10. Fong T. Not so special. Doc ownership in specialty hospitals scrutinized by healthcare panel. *Mod Healthc.* 2003;33:20–21.
11. Government Accountability Office. Report to the Congress: Physician-owned specialty hospitals. Washington, DC: Government Accountability Office; 2005:1–51.
12. Guterman S. Specialty hospitals: a problem or a symptom? *Health Aff.* 2006;25:95–105.

13. Herzlinger RE. Specialization and its discontents: The pernicious impact of regulations against specialization and physician ownership on the US healthcare system. *Circulation.* 2004;109:2376–2378.
14. Hwang CW, Anderson GF, Diener-West M, Powe NR. Comorbidity and outcomes of coronary artery bypass graft surgery at cardiac specialty hospitals versus general hospitals. *Med Care.* 2007;45:720–728.
15. Kahn CN, III. Intolerable risk, irreparable harm: the legacy of physician-owned specialty hospitals. *Health Aff.* 2006;25:130–133.
16. Katz JN, Bierbaum BE, Losina E. Case mix and outcomes of total knee replacement in orthopaedic specialty hospitals. *Med Care.* 2008;46:476–480.
17. Katz JN, Losina E, Barrett J, Phillips CB, Mahomed NN, Lew RA, Guadagnoli E, Harris WH, Poss R, Baron JA. Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States medicare population. *J Bone Joint Surg Am.* 2001;83:1622–1629.
18. Losina E, Barrett J, Baron JA, Levy M, Phillips CB, Katz JN. Utilization of low-volume hospitals for total hip replacement. *Arthritis Rheum.* 2004;51:836–842.
19. Losina E, Barrett J, Mahomed NN, Baron JA, Katz JN. Early failures of total hip replacement: effect of surgeon volume. *Arthritis Rheum.* 2004;50:1338–1343.
20. Mitchell JB, Bubolz T, Paul JE, Pashos CL, Escarce JJ, Muhlbaier LH, Wiesman JM, Young WW, Epstein RS, Javitt JC. Using Medicare claims for outcomes research. *Med Care.* 1994;32(7 Suppl):JS38–51.
21. Nallamothu BK, Lu X, Vaughan-Sarrazin MS, Cram P. Coronary revascularization at specialty cardiac hospitals and peer general hospitals in black Medicare beneficiaries. *Circ Cardiovasc Qual Outcomes.* 2008;1:116–122.
22. Nallamothu BK, Wang Y, Cram P, Birkmeyer JD, Ross JS, Normand SL, Krumholz HM. Acute myocardial infarction and congestive heart failure outcomes at specialty cardiac hospitals. *Circulation.* 2007;116:2280–2287.
23. Norton EC, Garfinkel SA, McQuay LJ, Heck DA, Wright JG, Dittus R, Lubitz RM. The effect of hospital volume on the in-hospital complication rate in knee replacement patients [see comment]. *Health Serv Res.* 1998;33(5 Pt 1):1191–1210.
24. Pham HH, Devers KJ, May JH, Berenson R. Financial pressures spur physician entrepreneurialism. *Health Aff (Millwood).* 2004;23:70–81.
25. Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, Saunders LD, Beck CA, Feasby TE, Ghali WA. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care.* 2005;43:1130–1139.
26. Reilly P. Picking patients. GAO: specialty hospitals serve fewer uninsured. *Mod Healthc.* 2003;33:6–7.
27. Rosenthal GE, Harper DL, Quinn LM, Cooper GS. Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. *JAMA.* 1997;278:485–490.
28. Schneider JE, Miller TR, Ohsfeldt RL, Morrisey MA, Zelner BA, Pengxiang L. The economics of specialty hospitals. *Med Care Res Rev.* 2008;65:531–553; discussion 554–563.
29. Shahian DM, Blackstone EH, Edwards FH, Grover FL, Grunkemeier GL, Naftel DC, Nashef SA, Nugent WC, Peterson ED. Cardiac surgery risk models: a position article. *Ann Thorac Surg.* 2004;78:1868–1877.
30. Shaw RE, Anderson HV, Brindis RG, Krone RJ, Klein LW, McKay CR, Block PC, Shaw LJ, Hewitt K, Weintraub WS. Updated risk adjustment mortality model using the complete 1.1 dataset from the American College of Cardiology National Cardiovascular Data Registry (ACC-NCDR). *J Invasive Cardiol.* 2003;15:578–580.
31. Specialty Hospitals. Specialty Hospitals: geographic location, services provided and financial performance. Vol 04-167. Washington, DC: General Accounting Office; 2003:1–41.
32. The Dartmouth Institute. The Dartmouth Atlas of Healthcare. Available at: http://www.dartmouthatlas.org/. Accessed April 5, 2009.
33. U.S. Census. U.S. Census 2000 Data. Available at: http://www.census.gov/main/www/cen2000.html. Accessed January 20, 2008.
34. Voelker R. Specialty hospitals generate revenue and controversy. *JAMA.* 2003;289:409-410.
35. Welch WP, Miller ME, Welch HG, Fisher ES, Wennberg JE. Geographic variation in expenditures for physicians' services in the United States. *N Engl J Med.* 1993;328:621–627.
36. Wilson BC. My hospital was doomed. *The Wall Street Journal.* January 5, 2006:A, 20.